JAPAN

EDICT OF GOVERNMENT

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JIS B 8251 (1981) (English): Construction of Welded Aluminum Alloy Liquefied Natural Gas Storage Tanks

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The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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UDC 621.642.3.036 : 669.715

JIS

JAPANESE INDUSTRIAL STANDARD

Construction of Welded Aluminium Alloy Liquefied Natural Gas Storage Tanks

JIS B 8251—1981

Translated and Published

by

Japanese Standards Association

Printed in Japan

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

UDC 621.642.3.036:669.715

JAPANESE INDUSTRIAL STANDARD J I S

Construction of Welded Aluminium Alloy Liquefied Natural Gas Storage Tanks

B 8251-1981
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies the general rules of construction of cylindrical vertical storage tanks with double shell, flat bottom, spherical roof, hereinafter referred to as the "storage tanks", having welded aluminium alloy inner tank out of on-ground storage tanks to store liquefied natural gas.

Remark: The units and numerical values given in { } in this Standard are in accordance with the International System of Units (SI), and are appended for reference.

2. Materials

2.1 General For the materials used for parts of storage tank to contact the liquefied natural gas, materials having sufficient mechanical property relating to the liquefied natural gas of -162°C shall be selected.

2.2 Inner Tank Materials Structural materials used for inner tank shall comply with the following Standards or be equal or superior thereto.

A 5083 P-0 of JIS H 4000

A 5083 BE-0, A 5083 BD-0 of JIS H 4040

A 5083 TE-0, A 5083 TD-0 of JIS H 4080

A 5083 S-0 of JIS H 4100

A 5083 FD-0, A 5083 FH-0 of JIS H 4140

2.3 Outer Tank and Attachment Materials The materials used for outer tank and attachment shall comply with the following Standards or be those equal or superior thereto in quality.

SS 41 of JIS G 3101

JIS G 3106

JIS G 3115

SF 40 A, SF 45 A of JIS G 3201

STK 41 of JIS G 3444

JIS G 3452

STPG 38 of JIS G 3454

Applicable Standards: See pages 37 & 38.

JIS G 3457

STPL 39 of JIS G 3460

S 20 C, S 25 C, S 45 C of JIS G 4051

SNB 7 of JIS G 4107

JIS G 4303

SUS 304 of JIS G 4304

SUS 304 of JIS G 4305

JIS H 4000, JIS H 4040, JIS H 4080, JIS H 4100, JIS H 4140

AC 4 C-T 6, AC 7 A-F of JIS H 5202

2.4 Filler Materials The filler materials used for welding of aluminium and aluminium alloy shall, as a rule, comply with the specifications of JIS Z 3232. However, for A 5083, those of A 5183-BY, A 5183-WY or those equivalent or superior thereto in quality.

3. Allowable Stress of Material

3.1 Allowable Tensile Stress The allowable tensile stress of material to be used for calculation shall be in accordance with JIS B 8243.

3.2 Allowable Shearing Stress The allowable shearing stress shall be 60 % of allowable tensile stress.

3.3 Allowable Compressive Stress The allowable compressive stress shall be obtained according to the following:

(1) In the case of $\lambda \leqq 20$

$$\sigma_c = \sigma_a$$

(2) In the case of $20 < \lambda \leqq \Lambda$

$$\sigma_c = \frac{1 - 0.4\left(\frac{\lambda}{\Lambda}\right)^2}{\nu} \sigma_{0.2}$$

(3) In the case of $\lambda > \Lambda$

$$\sigma_c = \frac{\sigma_{0.2}}{3.75\left(\frac{\lambda}{\Lambda}\right)^2}$$

where σ_c: allowable compressive stress (kgf/mm^2) {N/mm^2}

σ_a: allowable tensile stress (kgf/mm^2) {N/mm^2}

$\sigma_{0.2}$: proof stress (kgf/mm^2) {N/mm^2}

λ: slenderness ratio of compressive material (compressive material $\lambda \leqq 160$, post material $\lambda \leqq 120$)

$$\lambda = \frac{l_k}{\gamma}$$

l_k: buckling length (cm), according to the following.

Concerning moving	Constraint			Free	
Concerning rotation	Both ends free	Both ends constraint	One end free, other end constraint	Both ends constraint	One end free, other end constraint
l_k	l	0.5 l	0.7 l	l	2 l

Remark: l: length of compressive material or post material (cm)

γ: modulus of longitudinal elasticity concerning the buckling axis (cm)

$$\nu=1.5\left(0.9+0.6\frac{\lambda}{\Lambda}\right)$$

provided $\nu \geqq 1.5$

$$\Lambda=\sqrt{\frac{\pi^2 E}{0.6\sigma_{0.2}}}$$

E: modulus of longitudinal elasticity (kgf/mm^2) {N/mm^2}.

3.4 Allowable Bending Stress The allowable bending stress shall be same as the allowable tensile stress.

3.5 Allowable Stress of a Fillet Weld The allowable shearing stress of a fillet weld of attachment to side plate shall be 60 % of allowable tensile stress, provided that for calculation the theoretical throat of a fillet weld shall be used.

4. Design

4.1 General The design general shall be as follows:

(1) The storage tank shall be designed by taking into consideration using of course, assembly, pressure resistance test, cool-down, inspection, etc.

(2) The storage tank is that to store liquefied natural gas in which inner tank, heat insulating material of bottom part, foundation and anchor strap are integral, and shall be designed by taking into consideration the correlation of each part of these.

(3) For anchor strap of storage tank, the gas pressure, liquid pressure, earthquake power and effect of temperature shall be taken into consideration, and the connecting part with its interior shall be free from excess local stress.

(4) The heat insulating material of storage tank shall have sufficient heat resistance required for design.

Further, the heat insulating material of bottom part shall have sufficient pressure bearing function relative to liquid pressure, gas pressure, etc., and the affect of earthquake and the like shall be taken into consideration.

(5) The foundation of storage tank shall be sufficiently rigid against liquid pressure, gas pressure, etc. and the affect of earthquake and temperature change shall be taken into consideration.

(6) The attaching part of nozzle of storage tank shall be free from excess stress due to estimated outer force.

(7) The outer tank shall retain heat insulating material and seal gas and be airtight structure.

(8) The outer tank shall be taken with sufficient countermeasures against corrosion.

4.2 Loads The storage tank shall be so designed that it is safe relative to the combination of load shown in the following and load considered to be required.

(1) Static Loads

(a) The load due to self-weight (including attachments) of storage tank

(b) The load due to heat insulating material

(c) The load due to weight of storage liquid

(d) The load due to gas pressure of storage liquid (including negative pressure)

(e) The load due to fallen snow (1)

(f) The load due to pressure of seal gas

(g) Other load to be considered

(2) Dynamic Loads

(a) The load due to wind pressure (1)

(b) The load due to earthquake

(c) Other load to be considered

Note (1) The load due to fallen snow, the load due to wind pressure shall be received only by exterior.

(3) Calculation of Loads The fallen snow load, wind load, earthquake load shall be as follows:

(a) Fallen Snow Load The fallen snow load per horizontal projection area of storage tank shall be obtained by multiplying the unit weight of fallen snow by vertical deepest fallen snow in the district.

The unit weight of fallen snow shall be not less than 2 kgf {20 N} for horizontal projection area 1 m² per 1 cm of fallen snow.

(b) Wind Load The wind load (Q) due to wind pressure shall be calculated according to the following formula. However, in the case where it is installed at a place having a fear of receiving strong wind such as seaside, river side, on mountain, etc. or where the height from the ground surface up to the crest of storage tank is not less than 25 m, the speed pressure shall be taken as 300 kgf/m² {3.1 kPa}.

$$Q=Aqk$$

where Q: wind load (kgf) {N}

A: pressure receiving area, being the maximum vertical cross section of storage tank (m²)

q: speed pressure (kgf/m²), $q=60\sqrt{h}$ {$q=0.6\sqrt{h}$ (kPa)}

k: wind force coefficient, being 0.4 for spherical roof, and 0.7 for cylindrical shell

h: height of storage tank from the ground (m)

(c) Load due to Earthquake Moving For the load due to earthquake moving, apply the load 0.3 time the self weight in horizontal direction and the load 0.15 time the self weight in vertical direction at its center of gravity, and make the combination of loads in horizontal direction and vertical direction the severe conditions.

Furthermore, the local vibration characteristics, ground conditions, etc. shall, in some cases, be taken into consideration.

4.3 Joints

4.3.1 Dimensions of Welds The dimensions of welds shall be as follows:

(1) In the case of butt welding, it shall be theoretical throat dimension.

(2) In the case of fillet weld, it shall be size of a fillet weld.

4.3.2 Restriction on Use of Welding The restriction on use of welding shall be as follows:

(1) The minimum dimension of fillet weld shall be as follows, except where specially specified.

(a) In the case where the plate thickness is 6 mm, the size of the fillet weld shall be not less than 6 mm.

(b) In the case where the plate thickness exceeds 6 mm, the size of fillet weld shall be not less than 1/3 time the thinner plate thickness and the minimum value, be 6 mm.

(2) For one side welding lap joint, it shall not be applied to those other than bottom plate, roof and attachments.

(3) The lap allowance of lap joint shall be not less than 5 times the nominal thickness of thinner plate.

4.3.3 Joints of Storage Tank The joints of storage tank body shall, as a rule, be in accordance with Fig. 1 and Fig. 2.

Fig. 1. Joints of Storage Tank

(1) Longitudinal Joint of Side Plate and Knuckle Plate

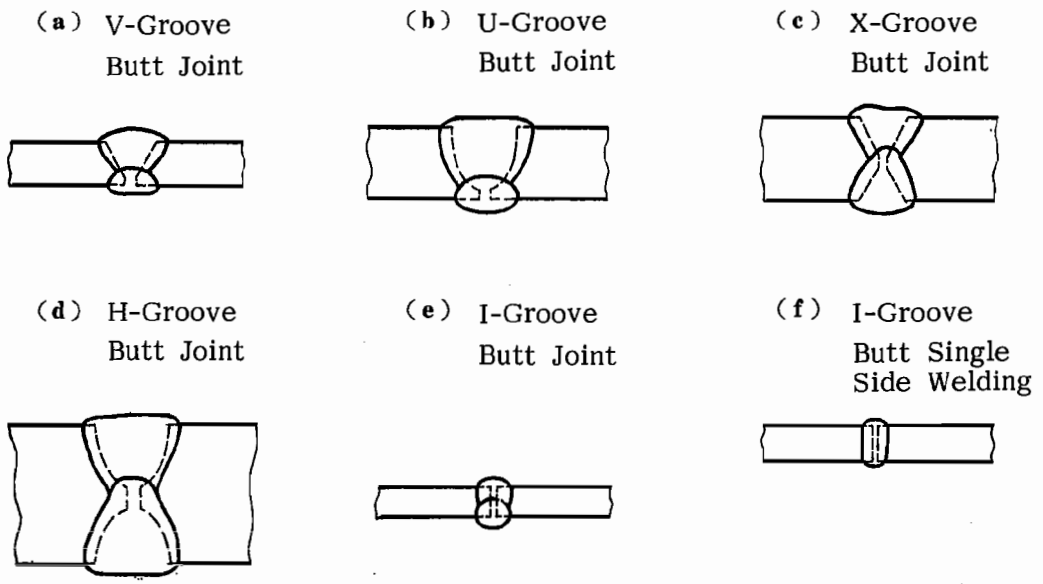
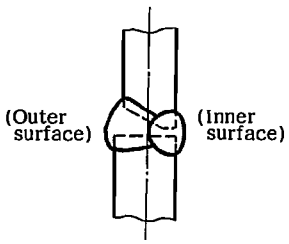


Fig. 1 (Continued)

(2) Horizontal Joint of Side Plate and Knuckle Plate

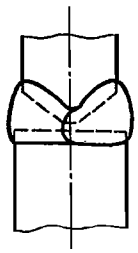
(a) I-Groove Butt Joint

(b) V-Groove Butt Joint

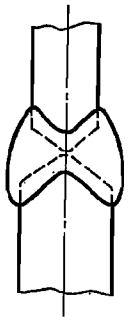


(c) V-Groove Butt Joint

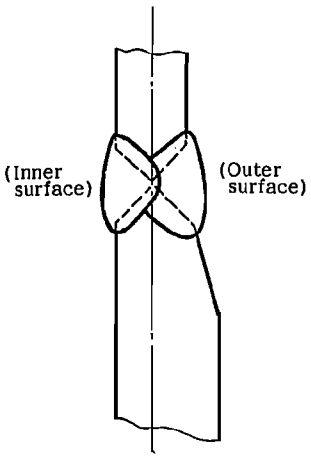
(d) K-Groove Butt Joint



(e) X-Groove Butt Joint

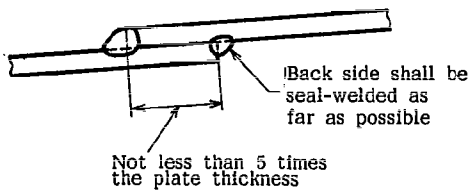


(f) X-Groove Butt Joint

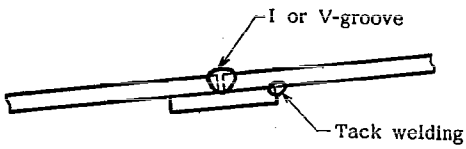


(3) Joints between Mutual Roof Plates

(a) Lap Joint



(b) Butt Joint (with Backing Metal)



(c) Butt Joint (One Side or Both Side Welding)

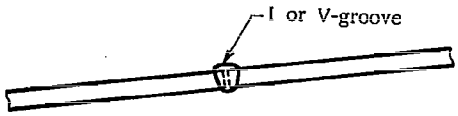
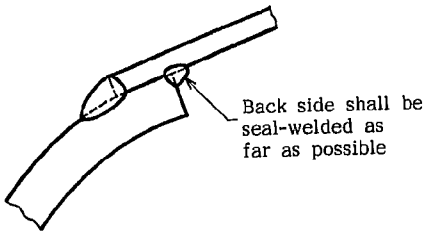


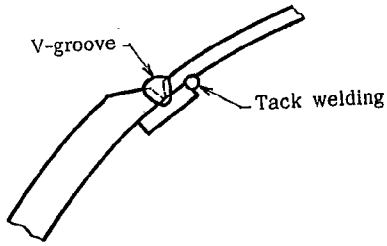
Fig. 1 (Continued)

(4) Joint of Roof Plate with Knuckle Plate

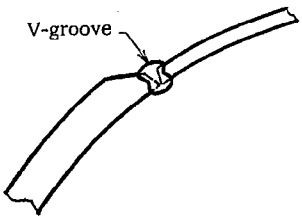
(a) Lap Joint



(b) Butt Joint (with Backing Metal)

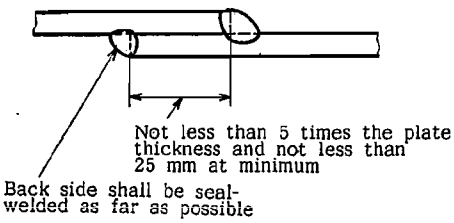


(c) Butt Joint

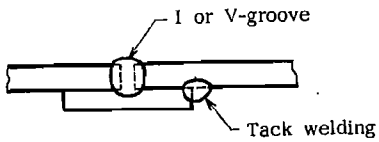


(5) Joint of Mutual Bottom Plates

(a) Lap Joint



(b) Butt Joint



(c) Butt One Side or Both Side Welding

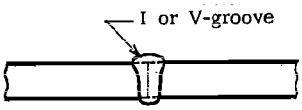
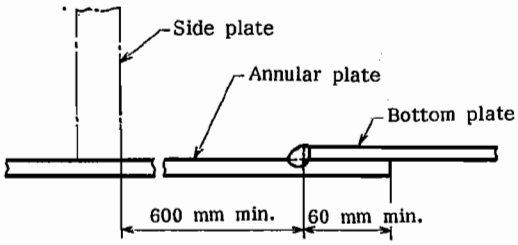


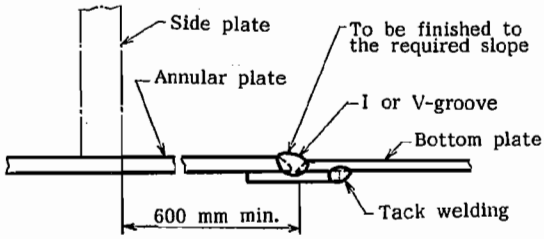
Fig. 1 (Continued)

(6) Joint of Bottom Plate with Annular Plate

(a) Lap Joint

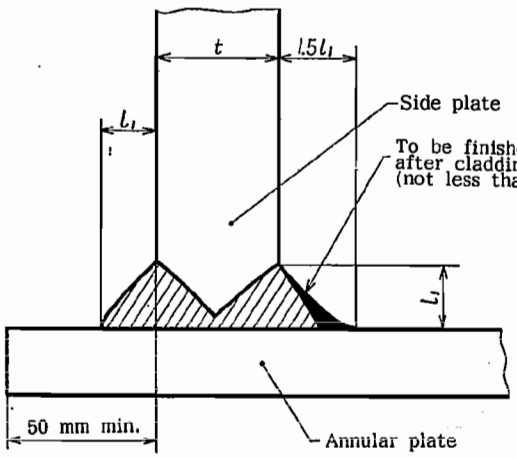


(b) Butt Joint



(7) T Joint of Annular Plate with Side Plate

(a) Example of Full Penetration Welding



(b) Example of Joint with Airtight Test Hole

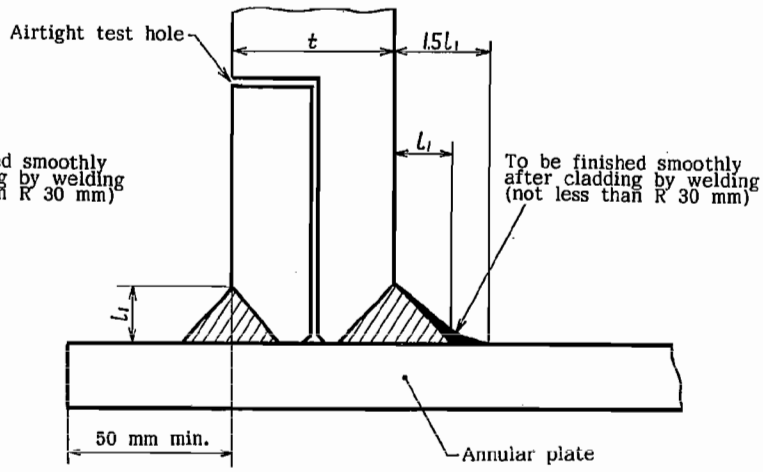
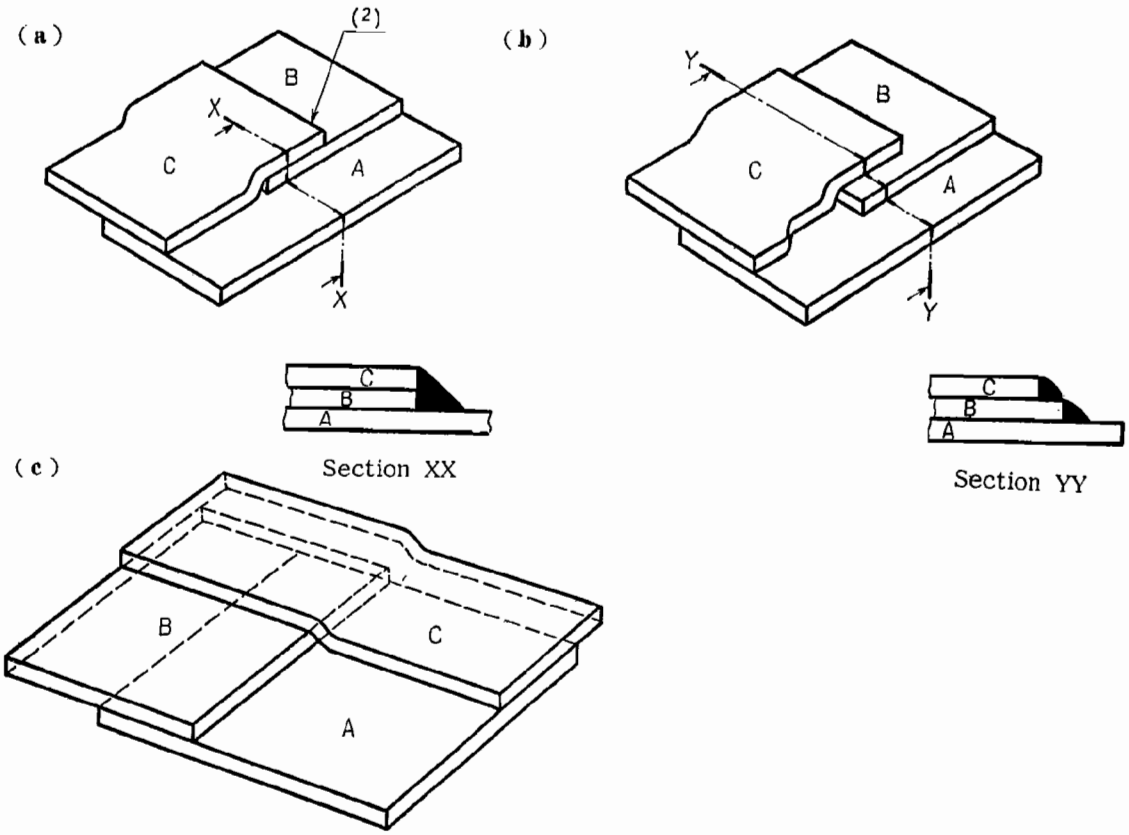


Fig. 2. Arrangement of Bottom Plates

(1) Assembly of Three Sheet Lap Part

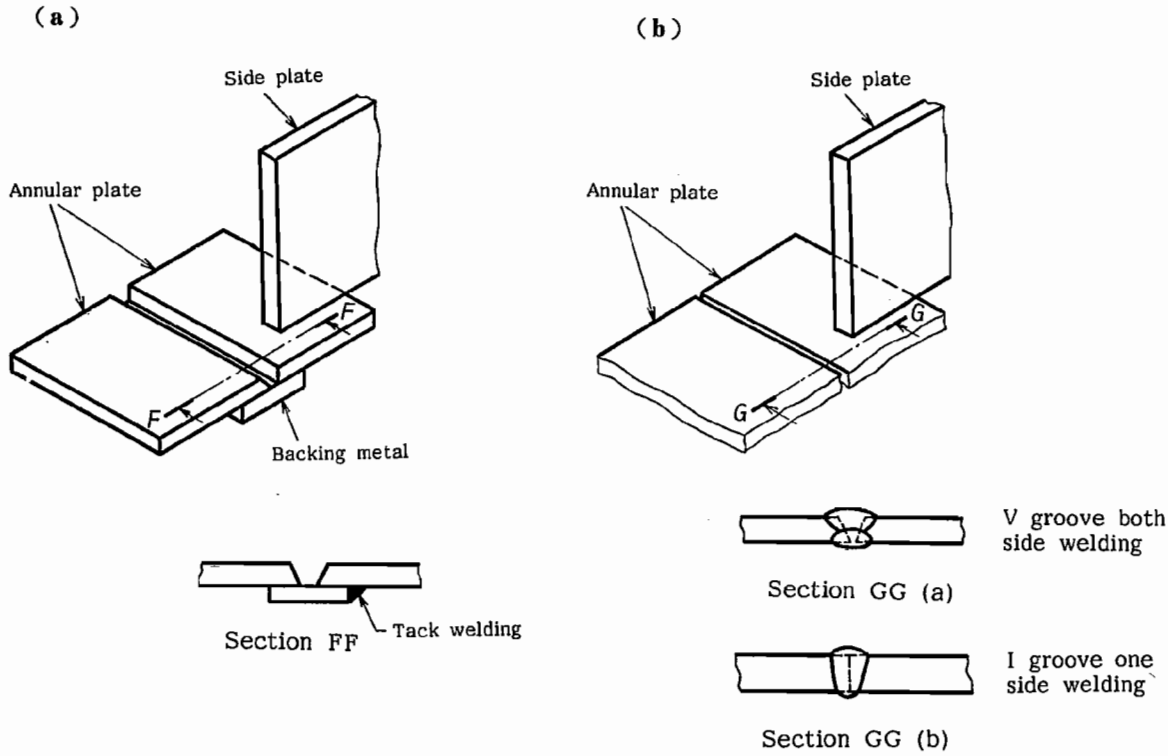


Note (2) This corner part shall be rounded or so notched that it is not interferent to welding.

Remark: A shows the lowest layer plate, B, the intermediate layer plate and C, the uppermost layer plate.

Fig. 2 (Continued)

(2) Assembly of Side Plate and Annular Plate



4.4 Inner Tank

4.4.1 Side Plate The structure of side plate shall be as follows:

(1) Thickness of Side Plate

(a) The thickness of side plate shall be not less than the value calculated according to the following formula:

$$t=\frac{PD}{200\sigma_a\eta-P} \quad \left\{t=\frac{PD}{2\sigma_a\eta-P}\right\}$$

where t: minimum plate thickness of side plate (mm)

P: pressure at lower weld line of each stage of side plate (3) (kgf/cm^2) {MPa}

D: inner diameter of inner tank (mm)

σ_a: allowable tensile stress of material (kgf/mm^2) {N/mm^2}

η: welding efficiency, to be 1.00

Note (3) The pressure applied on the side plate shall be the sum of liquid head pressure when the liquid to be stored is filled up to the highest liquid level and the gas pressure corresponding to the design pressure.

(b) The minimum plate thickness of side plate to be used actually shall be in accordance with Table 1.

Table 1

Internal tank inner diameter m	Minimum plate thickness mm
Under 35	8
35 to 60 excl.	10
60 and over	12

(2) Reinforcement of Side Plate The side plate shall be provided with so sufficient reinforcement, as required, that the buckling by external pressure due to heat-insulating material and the like is not caused.

(3) Buckling of Side Plate The plate thickness of side plate, in order to prevent buckling of side plate, shall satisfy the relation of following formula:

$$\frac{N}{A}+\frac{M}{\sqrt{2}Z}\leqq\frac{0.4}{\gamma}E\frac{t}{D}$$

where N: inner tank self weight of the part upper than the height to be discussed and the dawnward load, in the case of earthquake, the value of inner tank self weight and load multiplied by vertical earthquake coefficient shall be added (kgf) {N}

M: overturning moment by earthquake at the height to be discussed (kgf · cm) {N · cm}

A: sectional area of side plate at the height to be discussed, to be πDt (cm^2)

Z: modulus of section of side plate at the height to be discussed, to be $\frac{\pi}{4}D^2t$ (cm^3)

E: longitudinal elastic modulus of aluminium, to be 7.00×10^5 kgf/cm^2 {6.86×10^6 N/cm^2}

γ: factor of safety for buckling, to be 2.25 for static load, and 1.5 for dynamic load

t: using thickness of side plate at the height to be discussed (cm)

D: inner diameter of storage tank (cm).

(4) Arrangement of Side Plates The arrangement of side plates and joints shall be as follows:

(a) The longitudinal joint and horizontal joint shall be butt weld and all of them be of full penetration.

(b) The neighboring upper and lower plate of horizontal joint shall be aligned at the inside surface of storage tank. However, as required, these may be so aligned that the centers of plate thickness coincide.

4.4.2 Bottom Plate and Annular Plate The structures of bottom plate and annular plate shall be as follows:

(1) The minimum plate thickness of bottom plate shall be 6 mm.

(2) The thickness (designation) of annular plate for side plate to be placed-on shall be decided by taking into consideration the liquid load, gas pressure, earthquake load and the like. However, the minimum plate thickness shall be in accordance with Table 2.

Table 2. Thickness of Annular Plate for Side Plate to Be Placed-on

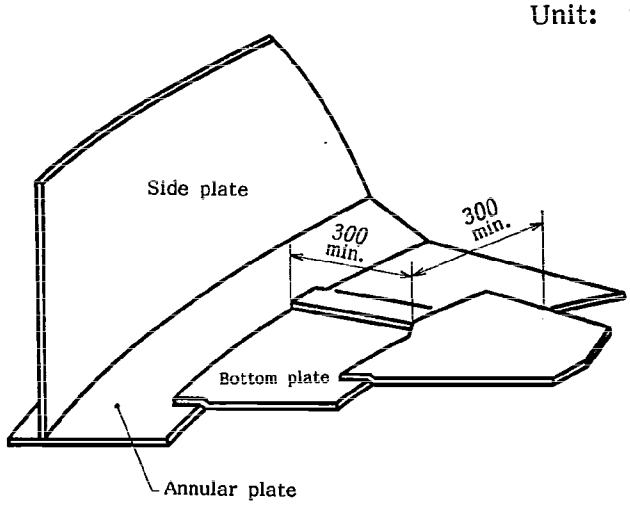
Unit: mm

Thickness of lowest stage side plate	Thickness of annular plate for side plate to be placed-on
Under 45	10
45 to 65 excl.	12
65 and over	15

(3) The structure of bottom plate shall be either one of lap joint, butt joint or combination of these, and be as follows:

Fig. 3

Unit: mm



(a) In the case where the joints of bottom plate are to be lap joints, the one side continuous full thickness fillet welding shall be carried out from the upper surface of bottom plate, and the back side should preferably be seal-welded, as far as possible. The lap allowance shall be not less than 5 times the plate thickness at the time of tacking.

The mutual distance of three sheet lap joint shall be not less than 300 mm (see Fig. 3).

(b) In the case where the bottom plate joint is to be butt joint, the butt welding of full penetration shall be carried out [see Fig. 1 (5) (b), (c)].

(4) The joint of annular plate to contact the side plate shall be the butt joint.

The butt weld joint of that part shall be both side weld joint, or one side weld joint using backing metal of not less than 3 mm in thickness or the joint having equivalent strength thereto.

(5) Attachment of side plate and annular plate shall be of both side continuous fillet weld joint as shown in Fig. 1 (7), and l_1 in the figure shall be larger than l_1 in Table 3.

Table 3

Unit: mm

Thickness of side plate	l_1
Under 25	7
25 to 50 excl.	10
50 to 70 excl.	14
70 and over	17

(6) The welding of annular plate and bottom plate shall be in accordance with one side fillet lap joint or one side butt welding to be carried out by using backing metal.

4.4.3 Roof The structure of the roof shall be as follows:

(1) The roof shall, as a rule, be self-support type spherical roof in which the roof plate its self has strength or the spherical roof supported by roof skeleton.

(2) The radius of curvature of roof shall be not less than 0.8 time the diameter of inner tank.

(3) The minimum plate thickness of roof plate shall be 6 mm.

(4) The plate thickness of roof plate shall be not less than the value calculated according to the following formula:

$$t=\frac{PR}{200\sigma_a\eta} \quad \left\{t=\frac{PR}{2\sigma_a\eta}\right\}$$

where t: thickness of roof plate (mm)

P: pressure due to vapour pressure (kgf/cm^2) {MPa}

R: radius of curvature of roof plate (mm)

σ_a: allowable tensile stress (kgf/mm^2) {N/mm^2}

η: weld joint efficiency.

(5) In the Case of Structure of Only Plate

(a) The joint of roof plate shall be butt joint.

(b) The roof plate shall have sufficient strength relative to negative pressure, self weight and other outer force, and relative to the buckling the relation of the following formula shall be satisfied:

$$|\sigma_1+0.8\sigma_2|\leq 0.06\frac{Et}{R}$$

where σ_1: the larger compressive stress (kgf/mm^2) {N/mm^2}

σ_2: the smaller compressive stress (kgf/mm^2) {N/mm^2}

E: longitudinal elastic modulus (kgf/mm^2) {N/mm^2}

t: roof plate thickness (mm)

R: radius of curvature of roof (mm).

(6) In the Case of Structure with Skeleton

(a) The joint of roof plate shall be in accordance with Fig. 1 (3).

(b) The allowable stress of support material shall be in accordance with 3.

(c) Each roof skeleton shall be so decided that the relations of the following formula are satisfied:

$$\frac{f_c}{F_c}+\frac{f_b}{F_b}\leq 1$$

$$\frac{f_t}{F_t}+\frac{f_b}{F_b}\leq 1$$

where f_c: compressive stress acting to roof skeleton (kgf/mm²) {N/mm²}

f_b: bending stress acting to roof skeleton (kgf/mm²) {N/mm²}

f_t: tensile stress acting to roof skeleton (kgf/mm²) {N/mm²}

F_c: allowable buckling stress (kgf/mm²) {N/mm²}

F_b: allowable bending stress (kgf/mm²) {N/mm²}

F_t: allowable tensile stress (kgf/mm²) {N/mm²}.

4.4.4 Connecting Part of Roof and Side Plate The connecting part of roof plate and side plate shall be provided with the following knuckle plate so as to be able to endure the compressive force generated by inner pressure.

(1) The radius of curvature of knuckle plate shall be not less than 0.06 time the diameter of inner tank.

(2) The joint of knuckle plate shall be in accordance with Fig. 1 (1), (2), and (4).

(3) The plate thickness of knuckle plate shall be such that the compressive stress (σ_s) in circumferential direction is not more than the allowable compressive stress (σ_{ac}) of knuckle plate (see Fig. 4). The calculation of compressive stress and allowable compressive stress shall be in accordance with the following.

(3.1) The compressive stress in the circumferential direction shall be calculated according to the following formula:

$$\sigma_s=\frac{PR_k}{100t}\left(\frac{R_k}{2r}-1\right) \quad \left\{\sigma_s=\frac{PR_k}{t}\left(\frac{R_k}{2r}-1\right)\right\}$$

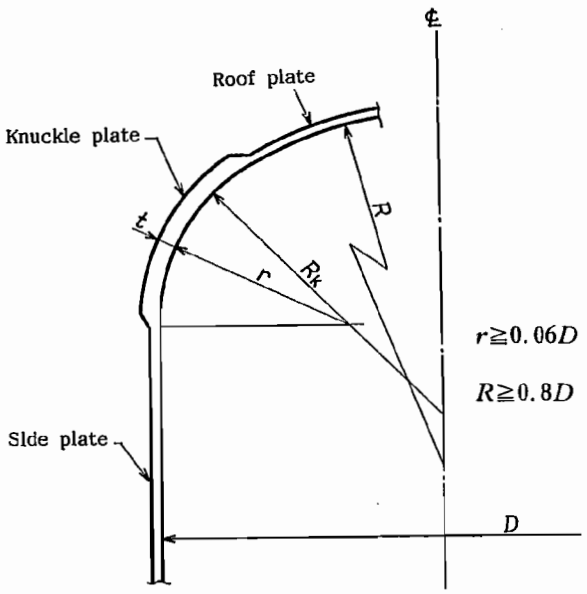
where P: the highest using pressure of storage tank (kgf/cm²) {MPa}

R_k: vertical distance from generating point of maximum compressive stress up to central axis of tank (mm)

t: plate thickness of knuckle plate (mm)

r: radius of curvature of knuckle plate (mm).

Fig. 4



(3.2) The allowable compressive stress of knuckle plate shall be calculated according to the following formulae and the smaller value shall be taken.

(a) $0.06\ E\frac{t}{r}$

(b) $m\sigma_a$

where $m=\frac{1}{2}(-n+\sqrt{4-3n^2})$

$n=\frac{PR_k}{200t\sigma_a}$

E: modulus of longitudinal elasticity of aluminium, to be 7.00×10^3 kgf/mm² {6.86×10^4 N/mm²}

σ_a: allowable tensile stress (kgf/mm²) {N/mm²}

t, r, P, R_k are same as symbols of (3.1)

4.4.5 Anchor Bolt (or Anchor Strap) The connecting part of side plate and annular plate shall be attached with anchor bolt (or anchor strap) so that no deformation is caused against upward force generated by gas pressure in the storage tank, earthquake force, etc. The anchor bolt (or anchor strap) shall satisfy the following items:

(1) The anchor bolt (or anchor strap) shall be safe structure in which the shrinkage due to temperature change in storage tank is taken into consideration.

(2) The attaching interval of anchor bolts (or anchor straps) shall be not more than 2.5 m. Provided that the center angle included by two neighbouring anchor bolts shall be not more than 30°.

(3) The attaching part of upper end of anchor bolt (or anchor strap) shall be such structure that no excessively large local stress is generated, and the lower end shall be rigidified strongly with the foundation directly or indirectly.

(4) The drawing-out force to act to one anchor bolt (or anchor strap) shall be calculated according to the following formula:

$$Q=\frac{\pi PD^2}{4N}+\frac{4M}{DN}-\frac{W}{N}$$

$$\left\{Q=\frac{\pi PD^2}{0.04N}+\frac{4M}{DN}-\frac{W}{N}\right\}$$

where Q: drawing-out force acting to one anchor bolt (kgf) {N}

P: gas pressure in inner tank (kgf/cm²) {MPa}

D: diameter of inner tank (cm)

N: number of pieces of anchor bolt (or anchor strap)

M: moment of overturning (kgf · cm) {N · cm}

W: self-weight at lower end part of side plate (kgf) {N}.

(5) Materials and allowable stresses of anchor bolt (or anchor strap) shall be dependent upon agreement between the parties concerned.

4.5 Reinforcement of Hole

4.5.1 The hole which is not less than 85 mm in diameter provided to the storage tank shall be reinforced by stiffening member attached in the effective range for reinforcement.

4.5.2 The minimum sectional area of stiffening member shall be calculated according to the following formula on each section of hole appearing in flat plane vertical to the plate surface containing center of the hole:

$$A=d\cdot t_r$$

where A: minimum sectional area of stiffening member (mm²)

d: in circular cylindrical part, diameter of hole appearing in longitudinal section, and in spherical surface, maximum diameter of hole (mm)

t_r: thickness required for calculation of cylinder or spherical body having no joint (mm).

4.5.3 The minimum sectional area required for stiffening member of hole at the part where the plate thickness is determined by outer pressure shall be 50 % of the value obtained in 4.5.2.

4.5.4 The effective range of reinforcement shall be as follows (see Fig. 5).

(1) The stiffening member shall be attached in the effective range of reinforcement.

(2) The effective range of reinforcement shall be the range enclosed by two lines along the plate surface and two lines parallel to the axis of hole, in a plane including the centre of hole and vertical to the plate surface.

(3) The lengths of four lines of (2) shall be as follows:

(3.1) The length along the plate surface shall be the larger value out of the following lengths by measuring from the center line of hole to the both sides.

(a) Diameter of hole appearing in each section (mm)

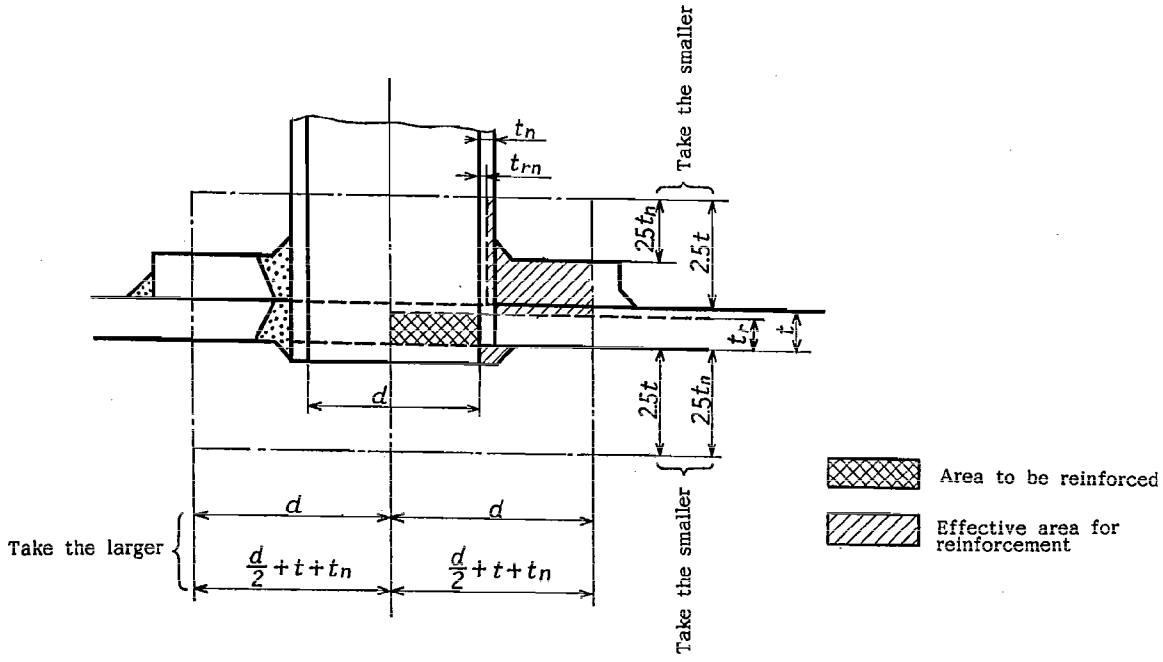
(b) The sum of radius of hole appearing in each section, thickness of plate, and thickness of nozzle stub wall (mm)

(3.2) The length of line parallel to the axis of hole shall be smaller value out of the following lengths, by measuring from the plate surface to each side.

(a) 2.5 times the plate thickness (mm)

(b) Sum of thickness 2.5 times the thickness of nozzle stub wall and the thickness of attached stiffening member (not containing deposited metal) (mm)

Fig. 5



(4) The parts of shell plate, spherical body or nozzle stub existing in the effective range of reinforcement, the parts of which thickness exceeds the minimum thickness and deposited metal for welding attachment may, in the following cases, be calculated in the stiffening member.

(a) Out of the shell plate or spherical body the area of the part which may be calculated-in as the stiffening member shall be the larger value out of the values calculated according to the following formulae:

$$A_1=(\eta t-t_r)d$$

$$A_1=2(\eta t-t_r)(t+t_n)$$

where A_1: area of shell plate or spherical body which may be calculated-in as the stiffening member (mm^2)

t: actual thickness of shell plate or spherical body (mm)

t_r: calculated thickness of seamless shell plate or spherical body without hole (mm)

d: diameter of hole in the face where reinforcement is considered (mm)

t_n: actual thickness of nozzle stub wall (mm)

η: efficiency of joint, and when the hole does not pass through the joint or passes through circumferential joint (excluding the joint attaching shell to head), take it as 1, and when the hole passes through longitudinal joint, take it as the efficiency of longitudinal joint.

(b) The area of the part which may be calculated-in as the stiffening member out of the nozzle stub shall be the smaller value of the values calculated according to the following formulae:

$$A_2=5t(t_n-t_{rn})$$

$$A_2=(5t_n+2t_e)(t_n-t_{rn})$$

where A_2: area of nozzle stub which may be calculated-in as stiffening member (mm^2)

t: actual thickness of shell plate or spherical body (mm)

t_n: actual thickness of nozzle stub wall (mm)

t_{rn}: calculated thickness of nozzle stub wall without joint (mm)

t_e: in the case of thickness of stiffening member or of integral type nozzle stub, length (mm) of one side embracing the right angle of nozzle stub side of right triangle of maximum 60° supported by container surface and nozzle stub outer wall part. (Provided that the oblique line of this triangle shall not extrude the integral type nozzle stub.).

(5) Attaching strength of stiffening member by welding shall not be less than the tensile strength of minimum section of stiffening member.

(6) The outer and inner circumferential welding of stiffening member shall be carried out completely over the whole circumference.

4.6 Outer Tank

4.6.1 Side Plate and Stiffener Ring The structures of side plate and stiffener ring shall be as follows:

(1) The plate thickness of side plate shall be not less than the value calculated according to the following formula:

$$t=\frac{PD}{200\sigma_a\eta}+C \quad \left\{t=\frac{PD}{2\sigma_a\eta}+C\right\}$$

where t: plate thickness of side plate (mm)

P: seal gas pressure and heat-insulating material side pressure (kgf/cm^2) {MPa}

D: inner diameter of outer tank (mm)

σ_a: allowable tensile stress (kgf/mm^2) {N/mm^2}

η: weld joint efficiency, in the case of both side butt weld, and where radiographic test is not carried out 0.7

C: corrosion allowance.

(2) The minimum plate thickness of side plate shall be in accordance with Table 4.

Table 4

Inner diameter of outer tank m	Minimum plate thickness mm
Under 15	4.5
15 to 36 excl.	6.0
36 to 60 excl.	8.0
60 to 75 excl.	10.0
75 and over	12.5

(3) The side plate shall comply with the relation of the following formula so that it does not buckle against shaft force from the self weight of storage tank (including attachments) or from the overturning moment due to earthquake force or wind load.

$$\frac{N}{A}+\frac{M}{\sqrt{2}Z}\leqq\frac{0.4}{r}E\frac{t}{D}$$

where N: outer tank self weight of the part upper than height to be discussed and downward load. In the case of earthquake, the value of outer tank felf weight and load multiplied by vertical earthquake coefficient shall be added (kgf) {N}.

M: overturning moment due to wind or earthquake at a height to be discussed (kgf · cm) {N · cm}

A: sectional area of side plate at a height to be discussed, being πDt (cm^2)

Z: moment of section of side plate at a height to be discussed, being $\frac{\pi}{4}D^2t$ (cm^3)

E: longitudinal elastic modulus of steel member, being 2.1 x 10^6 kgf/cm^2 {2.06 x 10^7 N/cm^2}

r: factor of safety relative to buckling, being 2.25 in the case of static load, and 1.5 in the case of dynamic load

t: plate thickness of side plate of outer tank (cm)

D: inner diameter of outer tank (cm)

(4) The side plate shall be provided with stiffener ring in order to prevent buckling against wind pressure and negative pressure between the inner and the outer tanks. In this case, attaching interval of stiffener rings and the section of stiffener rings shall be as follows (see Fig. 6).

(a) Each attaching interval (l_p cm) of actual stiffener rings shall be less than the value of required interval (l_r) calculated from the following formula:

$$l_r = D\sqrt{\frac{t_m}{D}}\left[0.45+\frac{2.6E}{P}\left(\frac{t_m}{D}\right)^2\right]$$

where l_r: stiffener interval (cm)

D: inner diameter of outer tank (cm)

t_m: average plate thickness of side plate at stiffener interval (cm)

E: longitudinal elastic modulus of steel, to be 2.1 x 10^6 kgf/cm^2 {2.06 x 10^7 N/cm^2}

P: the larger out of wind pressures or negative pressures between the inner and outer tanks subtracted by heat-insulating member side pressure (kgf/cm^2) {N/cm^2}.

(b) For section of stiffener ring, the geometrical moment of inertia calculated by adding to effective section of stiffener by 16 t up and down from each stiffener attaching part (t is the side plate thickness at attaching part) shall be not less than the value calculated according to the following formula:

$$I_i = \frac{PD^3h_i}{8E(n^2-1)}$$

where I_i: required geometrical moment of inertia (cm^4)

h_i: center to center distance of upper and lower stiffener rings, that is $\frac{l_{i-1}}{2}+\frac{l_i}{2}$ (cm)

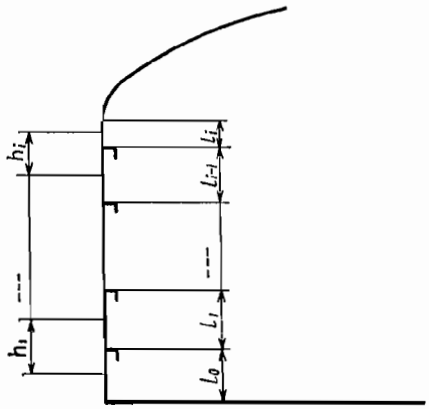
$$n = \sqrt[4]{\frac{7.06}{\left(\frac{H}{D}\right)^2\left(\frac{T_m}{D}\right)}}$$

T_m: average plate thickness of side plate at whole height (cm)

H: side plate whole height (cm)

D, P, E shall be in accordance with (a).

Fig. 6



4.6.2 Bottom Plate The bottom plate shall be as follows:

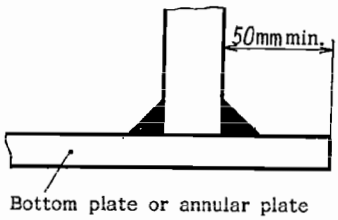
(1) The minimum plate thickness of bottom plate shall be 4.5 mm.

(2) The part of bottom plate to be placed-on with side plate shall, as required, be provided with annular plate.

(3) The structure of bottom plate shall be of lap one side fillet welding. The lap allowance shall be not less than 25 mm, and the mutual distance of three sheet lap joint shall be not less than 300 mm.

(4) The joint between the side plate and bottom plate (or annular plate) shall be in accordance with Fig. 7. The leg of a fillet weld shall be same as the thinner plate thickness.

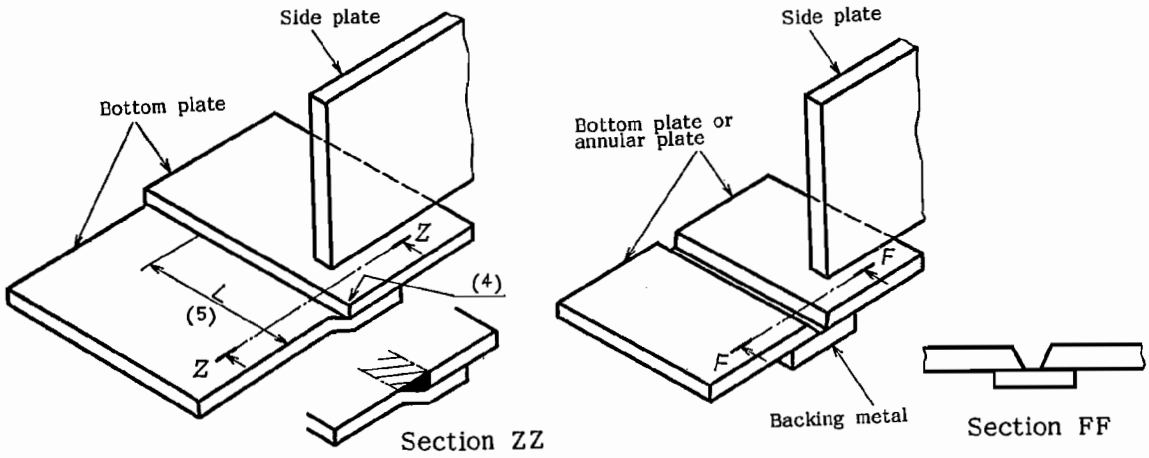
Fig. 7



(5) Assembly of three sheet lap part shall be in accordance with Fig. 2 (1).

(6) Assembly of side plate and bottom plate (or annular plate) shall be in accordance with Fig. 8.

Fig. 8. Assembly of Side Plate and Bottom Plate



Notes (4) This corner shall be rounded.

(5) The part of L shall be so finished that the upper surface of bottom plate becomes smooth by cladding from the inside surface of side plate to length of minimum 150 mm.

4.6.3 Roof The structure of roof shall be as follows:

(1) The roof shall be a spherical roof supported by roof skeleton.

(2) The minimum plate thickness of roof plate shall be 4.5 mm.

(3) The joint of roof plate shall be one-side full-thickness-lap fillet welding.

(4) The pitch of circumferential direction attachment of roof skeleton shall, as a rule, be 2000 mm at maximum. However, except where the roof plate has sufficient strength against outer load.

(5) The roof shall endure sufficiently the load from earthquake, wind to act on piping and from the piping support bearing heat load.

(6) The plate thickness of roof plate shall be not less than the value calculated according to the following formula:

$$t=\frac{PR}{200\sigma_a\eta}+C \quad \left\{t=\frac{PR}{2\sigma_a\eta}+C\right\}$$

where t: plate thickness of roof plate (mm)

P: seal gas pressure (kgf/cm^2) {MPa}

R: radius of curvature of roof plate (mm)

σ_a: allowable tensile stress 10.3 kgf/mm^2 {101 N/mm^2}

η: weld joint efficiency, to be 0.45

C: corrosive allowance.

(7) The fitting part of roof and side plate, in the case where compressive force is generated by inner pressure, shall be provided with compression ring to prevent buckling. Furthermore, the part shall have sufficient strength against tension and bending due to roof self weight and downward load acting on roof.

4.6.4 Anchor Bolts The anchor bolts of outer tank shall be in accordance with 4.4.5, as appropriate.

4.7 Thermal Insulation

4.7.1 Thermal Insulation Structure The thermal insulation structure shall be as follows:

(1) The thermal insulation structure shall be sufficient to prevent intrusion of heat into inner tank to the required degree and be such that the thermal insulation effect is not damaged by affects of temperature change, earthquake, pressure variation in inner tank, etc.

(2) Thickness of thermal insulation layer shall be such that the moisture condensation is not generated on the surface of outer tank at ordinary time.

(3) The thermal insulation layer shall, as a rule, be filled with dry nitrogen for moisture prevention or safety.

4.7.2 Thermal Insulation Materials The thermal insulation materials shall be as follows:

(1) The thermal insulation materials shall be of non-inflammability and have required heat resistance.

(2) The thermal insulation materials used for the bottom part shall have sufficient strength to endure the static load due to inner tank and stored liquid, inner tank gas pressure as well as earthquake load or temperature change.

4.8 Foundation The foundation of storage tank shall be as follows:

(1) At designing the foundation, the data concerning the ground required for affirmation of bearing layer, discussion of safety of ground, and design and execution of works shall be obtained.

(2) The foundation shall have sufficient pressure resistance and bearing force relative to the load such as liquid pressure, gas pressure, etc.

(3) The foundation shall be designed by taking into consideration the affect due to earthquake force, temperature change, etc. and also the mutual relation of inner tank, thermal insulation materials, etc.

(4) Materials to be used for foundation such as concrete, reinforcement, etc. and required items such as allowable stresses of those shall be determined adequately according to agreement between the parties concerned.

5. Working

5.1 Affirmation of Materials The materials to be used for manufacture of storage tank shall be inspected on material characteristics, quality, dimensions, appearance, etc. prior to working according to the material test result table issued by the manufacturer of material or a suitable method instead of it.

Further, identification method for cutting flaws of materials shall be taken.

5.2 Forming Works In the case of forming works of material are carried out, such method as to deteriorate remarkably the characteristics of material shall not be taken.

5.3 Cutting and Groove Working The cutting of material and working of edge part shall be carried out by sawing, chipping, shear machine, plasma cutting, etc.

The groove working shall be carried out in accordance with JIS Z 3604, as appropriate.

5.4 Bend Working of Side Plate In order to coincide with the curvature of side plate of storage tank, preliminarily the bend working of side plate shall be carried out.

5.5 Attaching Attachments For welding the attachments with working the storage tank body or attaching the attachments by direct welding, the attachment shall be carried out prior to pressure resistance test of storage tank.

5.6 Strain Removing and Heat Working Strains shall, as required, be corrected by mechanical method, point or line heating method, or the like.

Mechanical strain removing shall be carried out by such method that the base metal surface is not damaged.

The strain removing by heating and quenching or hot working shall be carried out in accordance with JIS Z 3604, as appropriate.

5.7 Welding

5.7.1 General Welding general shall be as follows:

(1) Welding of storage tank body and its structural members shall be in accordance with JIS Z 3604 or the welding method equivalent or superior thereto, and be carried out according to the welding execution method confirmed by 6.

(2) The welding work shall be carried out by a welding worker of qualified person recognized according to JIS Z 3811 or the reference equivalent or superior thereto and also having qualification adequate to welding work of the part to be welded.
The automatic welding shall be carried out by an operator skilled in respective welding works and in operation of welding apparatus.
The welding work shall be carried out under supervision of welding execution control engineer having technical knowledge and experience concerning welding execution.

(3) Welding shall be carried out under the condition where the welding place is cleaned and dried. Specially, care shall be taken for the welding work under the environment having wind, rain, and remarkably moisture.

(4) The filler metal and welding set shall be made clean, and the surface of filler material shall be free from stains such as oil or the like and adhesion of moisture.

(5) For tack welding, sufficient care shall be so taken that defects do not remain at weld, and further care shall be taken for bead length, pitch, etc., and furthermore for the following items:

(a) The filler material to be used shall be equivalent to that used for main welding.

(b) The root gap shall be held adequate and uniformly, and be so made that stagger is not generated when main welding is carrying out.

(c) Tack welding of side plate longitudinal joint, that of side plate and annular plate (except where partial groove is removed.) and that of mutual annular plates shall be carried out on back chipping side or be so corrected that interference to main welding is not caused. However, in the cases of carrying out automatic welding and of tack welding of bottom plate joints, roof plate joints, etc. exclusively where no defect such as crack at that part is affirmed, it may be not removed.
Further, at the time of main welding, sufficient penetration into deposited metal shall be made.

5.7.2 Bottom Plate Welding of bottom plate shall be as follows:

(1) Welding of bottom plate shall be so carried out that the deformation becomes small.

(2) The part of lap joint of bottom plate, after confirming that the weld of lower plate is adequate, shall be welded by lapping the upper plate.

(3) In order to make welding strain of bottom plate little, take care for welding sequence, and the annular plate, after welding with side plate, shall be welded with bottom plate of inner part.

(4) The lap joints of mutual bottom plates, and of bottom plate and annular plate shall be welded by two passes or over.

(5) In the case where for butt joint of bottom plates or annular plates permanent backing metal is used, such care that the initial layer is free from defects such as cracks, and the like shall be taken.

5.7.3 Side Plates Welding of side plates shall be as follows:

(1) For butt joint parts of side plates, the side plates shall be carried out with accurate positioning and care shall be taken so that those do not move during welding working.

(2) The stagger of joining surfaces in butt joint shall not exceed 1 mm to plates of not more than 20 mm in thickness, and to plate exceeding 20 mm shall not exceed 5 % of plate thickness or 3 mm whichever is the smaller valve.

(3) The stagger of joining surfaces with the upper stage plate of butt horizontal joint, in the case where the upper stage plate thickness is not more than 15 mm, shall not exceed 1.5 mm and for plate of which upper stage plate thickness exceeds 15 mm, it shall not exceed 10 % of the plate thickness or 6 mm, whichever is the smaller value.

(4) For butt both side welding joint, except downward automatic welding, back chipping shall, as a rule, be carried out.

(5) The weld joint of side plate shall be free from harmful defects such as undercut, overlap, etc.

5.7.4 Side Plate and Annular Plate Welding of side plate with annular plate shall be as follows:

(1) For welding of side plate with annular plate, the position shall be carried out correctly by using jig or the like, and after fixing by tack welding or other methods, continuous welding shall be carried out. At this time, the welding sequence shall be so taken into consideration that excessive deformation is not generated on annular plate.

(2) For toe part of annular side of inner surface, fillet welding shall be carried out and further so finished that gradual shape is made with annular plate.

5.7.5 Roof Welding of roof shall be so carried out that the deformation becomes small, and the rafter are so arranged that their upper surfaces and arrangement are coincident.

5.7.6 Attaching the Attachments For the weld attaching the attachments, taking into consideration the assembling sequence, preliminarily the nozzle, manhole, etc. shall be attached on the ground, and the existence of defects such as cracks, and the like shall be affirmed according to nondestructive test before assembling the body.

6. Affirming Test for Welding Execution Method

At the time of welding of storage tank, preliminarily the affirming test for welding execution method shall be carried out according to JIS Z 3041 by the same method as the welding method to be used for welding of storage tank. However, in the following cases, a part or all parts of the affirming test for welding execution method may be omitted, depending upon agreement between the parties concerned:

(1) In the case of manufacturing according to the welding execution method fully similar to the affirming test previously carried out.

(2) In the case where the same type storage tanks are simultaneously manufactured and confirmed that it is represented by once affirming test.

(3) Otherwise, in the case where it is affirmed that it may be omitted.

7. Mechanical Tests of Weld

For the butt weld of pressure-resistant part, the mechanical tests specified in 7.2 shall be carried out on the test plate prepared according to the following during manufacturing and the results shall comply with them.

(1) In the case of carrying out welding of longitudinal joint of storage tank, for each different welding condition concerning the storage tank one test plate shall be prepared successively to welding of the storage tank or separately prepared by welding under the same conditions.

(2) In the case of carrying out welding of circumferential joint of storage tank, for each different welding condition concerning the storage tank one test plate shall be prepared successively to welding of the storage tank separately by welding under the same conditions. However, except where the welding is carried out under the same conditions as those of test plate of (1).

7.1 Test Plate The test plate shall be as follows:

(1) The test plate of which base metal shall be of the same type as that specified in JIS to be applied, and made of material of same thickness, and be so made that the camber is not generated by welding.

(2) In case where the camber is generated on the test plate by welding, it shall be corrected before working to test piece.

7.2 Mechanical Tests The mechanical tests to be carried out on welding test plate shall be as follows:

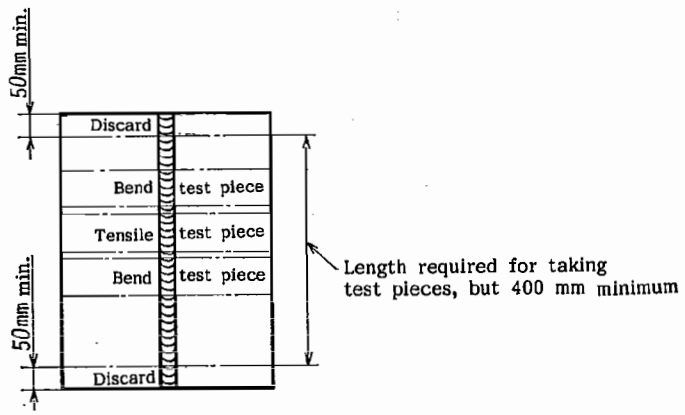
(1) Classification and number of mechanical tests to be carried out on test plate shall be in accordance with Table 5.

Table 5. Classification and Number of mechanical Tests

Classification of mechanical tests	Number
Tensile test	1
Side bend test	When the plate thickness is not less than 20 mm 1
Root bend test	When the plate thickness is less than 20 mm (except where butt both side welding is carried out.) 1
Face bend test	1

(2) The test pieces to be used for mechanical test shall be taken according to Fig. 9 from the test plate.

Fig. 9. Test Pieces to Be Used for Mechanical Tests



7.3 Mechanical Test Methods and Judgement

7.3.1 The shape and dimensions of test pieces, test methods and judgement of test results shall be in accordance with 6.

7.3.2 Retest In the case where the mechanical test specified in 7.3.1 is carried out and the results have been not acceptable and correspond to following (1), retest may be carried out. For taking method of retest pieces, two test pieces per one unacceptable test piece shall be taken from the same test plate or the test plate prepared at the same time as this.

Furthermore, in case where the size of test plate is less than the size required for taking retest pieces, the test plate may newly be prepared by the welding worker who has prepared the unacceptable test pieces under the same conditions.

(1) Conditions for Carrying-Out Retest

(a) In tensile test, when the results are not less than 90 % of specifications.

(b) In side bend test, root bend test, or face bend test, the reasons for non-compliance are considered to be other than the defects of weld metal.

(2) Judgement of Test Results If the retest pieces have complied with the judgements of respective test results, the results shall be taken to be acceptable.

8. Assembling

8.1 Foundation of Storage Tank The execution of foundation of storage tank shall be so carried out that the quality required for complying with the design of 4.8 is secured.

8.2 Assembling of Storage Tank At the time of assembling the body of storage tank, the fact that the assembly dimensional errors on circularity, perpendicularity, etc. are within the allowable deviation shall be affirmed.

8.3 Painting In the outer tank or the like, when painting is applied before assembling, the weld shall not be painted. The weld shall be inspected and after affirming that no defect exists the painting shall be carried out.

8.4 Temporary Attaching Metal For removing jigs and attaching metals for temporary works to be attached to the side plate for assembling the storage tank, cares shall be so taken that the base metal is not attached with flaws.

9. Tests and Inspection

9.1 General The storage tank shall, always, be applied with appearance inspection in the process of manufacture in order to maintain the quality and performance and also the fact that the execution method specified in welding execution method confirming test is maintained shall be affirmed.

Further, as occasion demands, the existence of defects on the following items shall be examined, and the defect parts shall be repaired completely according to the corresponding items of this Standard, and then the retest, be carried out to affirm that the defects are removed.

(1) Inspection of using material before assembling

(2) Nondestructive test of butt weld of annular plate

(3) Nondestructive test of T joint weld of annular plate with the side plate lowest stage

(4) Nondestructive test of bottom plate joint weld

(5) Nondestructive test of butt weld joint of side plates

(6) Nondestructive test of opening part

(7) Leakage test of bottom plate, and annular plate

(8) Leakage test of weld of opening part stiffening member

(9) Pressure resistance test

(10) Leak test by filling water

(11) Airtight test

(12) Nondestructive test after leak test by filling water

(13) Performance test of attachments

(14) Test of safety valve

(15) Test of thermal insulation member

(16) Test of anchor strap

(17) Test of foundation

9.2 Test and Inspection Methods

9.2.1 Inspection of Using Material before Assembling For the using material before assembling to be for the joint efficiency to be 100 %, ultrasonic testing on the part to be its groove as object, having not less than 20 mm in plate thickness shall be carried out.

9.2.2 Nondestructive Test of Annular Plate Butt Weld The annular plate butt weld shall be subjected to liquid penetrant testing.

Further, in the case where butt welding without using backing metal is carried out radiographic test shall be carried out.

9.2.3 Nondestructive Test of T Joint Weld of Annular Plate and Side Plate Lowest Stage For the T-joint weld of annular plate and side plate lowest stage, the liquid penetrant test on fillet weld shall be carried out.

Further in the case where a joint attached with airtight test hole is used for T joint of annular plate and side plate is used, air pressure or other inert gas pressure of 5 kgf/cm^2 {500 kPa} in gauge pressure is applied and the leakage at weld shall be examined.

9.2.4 Nondestructive Test of Bottom Plate Joint Weld For bottom plate joint weld, liquid penetrant testing shall be carried out.

Further, in the case where butt welding without backing metal is carried out, radiographic test shall be carried out.

9.2.5 Nondestructive Test of Side Plate Butt Weld Joint The side plate butt weld joint part shall be subjected to liquid penetrant test and further to radiographic test.

9.2.6 Nondestructive Test of Opening Part The opening part including the weld of stiffening member shall be subjected to liquid penetrant test.

9.2.7 Leakage Test of Bottom Plate and Annular Plate For weld of bottom plate and annular plate, the leakage shall be examined by making the weld vacuum and by using soap water or the like. In this case, the degree of vacuum shall be lower than the value of at least 400 mm in mercury column {53.3 kPa}.

9.2.8 Leakage Test of Opening Part Stiffening Member Weld For the opening part stiffening member weld shall, prior to pressure resistance test, be applied with air pressure or other inert gas pressure of 1 kgf/cm^2 {100 kPa} in gauge pressure from the telltale hole of stiffening member and leakage at weld shall be examined.

9.2.9 Pressure Resistance Test The pressure resistant part of storage tank shall be carried out with filling water up to not lower than the water level corresponding to the design liquid head pressure, apply air pressure not less than 1.5 times the maximum using pressure to the gas phase part to carry out the pressure resistance test, and endure thereto.

9.2.10 Leak Test by Filling Water For storage tank, successively to the pressure resistance test, the leak test by filling water shall be carried out.

For the leak test by filling water, the filling water shall, as a rule, be carried out up to the height not lower than 1.5 times the water level corresponding to the design liquid head pressure at the lowest part of side plate (up to the design liquid level shall be taken as the limit.), and then there shall be no abnormality on inner tank lower part and foundation.

9.2.11 Airtight Test The pressure resistant part of storage tank shall be applied with air pressure not less than 1.1 times the maximum using pressure, the weld, be coated with soap water, the leakage at weld, be examined and there shall be no leakage.

9.2.12 Nondestructive Inspection after Leak Test by Filling Water After leak test by filling water, the welds of bottom plate and annular plate shall be subjected to liquid penetrant test and vacuum leak test, and the T joint weld of annular plate and side plate lowest stage, be subjected to liquid penetrant test.

9.3 Nondestructive Test and the Judgement Reference

9.3.1 Ultrasonic Testing The ultrasonic testing of using material shall be decided to depend upon agreement between the parties concerned. However, when lamination is found, the material shall, as a rule, be substituted.

9.3.2 Liquid Penetrant Testing The liquid penetrant testing shall be in accordance with JIS Z 2343. The judgement reference shall be decided to depend upon agreement between the parties concerned.

9.3.3 Radiographic Testing The radiographic testing shall be in accordance with JIS Z 3105.

Further, the photographing engineer shall be a person having qualification by JIS Z 3861 or a person having technique equivalent or superior thereto. The photographing conditions and judgement reference shall be as follows:

(1) The reinforcement of weld of joint to be subjected to radiographic testing shall be not more than the value of Table 6.
Further, the bead surface shall be as smooth and uniform shape as possible and the angle included by base metal and bead surface at bead toe, be as gentle shape as possible.

Table 6

Thickness of side plate t (designation) mm	Maximum height of reinforcement of weld mm
Under 15	1/3 t
15 to 25 excl.	5
25 and over	7

(2) By taking into consideration the plate thickness, welding conditions, etc., after completion of welding of a definite length for each stage, the radiographic test should preferably be carried out as quickly as possible.

(3) The photographing place shall be as follows depending upon the plate thickness, joint efficiency to be used.
Further, the optional place at photographing position shall be decided to depend upon agreement between the parties concerned.

(a) Horizontal Joint of Side Plate Concerning not less than 20 % of overall length of weld line, the photographing shall be carried out by sampling from optional place.

(b) Longitudinal Joint of Side Plate The overall length (100 %) of weld line shall be photographed.

(4) The results of radiographic testing shall comply with Grade 1 or Grade 2 out of classification of radiographs specified in JIS Z 3105.

(5) In case where the test place is not accepted, it shall be as follows:

(a) In case where it is not accepted according to judgement reference of (4), the neighboring both places shall be photographed in addition.

(b) In case where the photographing results of neighboring welds photographed according to (a) also have not complied with the judgement reference of (4), the further neighboring places shall be photographed. Thus, the photographing place shall be added until the photographing results are accepted, and the range of not accepted shall be examined.

9.4 Repairing of Welding Defect parts The repairing of welding defect parts found according to test shall be as follows.

Further, the welding worker to carry out the welding repair shall be a person having qualification specified in 5.7.1 (2).

(1) the defects at joint of side plate, joint of side plate with annular plate or bottom plate and at opening part attaching place shall be chipped sufficiently and after rewelding, retest shall be carried out.

(2) The harmful defects such as cracks and the like at the joints of bottom plate and roof plate shall be chipped sufficiently and after rewelding, retest shall be carried out.

10. Preparation and Storage of Records

The manufacturer shall prepare the following records and offer depending upon the requirement by purchaser.

(1) Manufacturing specifications, strength calculation documents of main parts and structural drawings

(2) material inspection result table of body main materials

(3) Records of welding execution method affirming test

(4) Records of intermediate and final tests of body main welds

(5) Records of radiographic test 9contining film)

(6) Records of leakage test

(7) Records of repairing of body main welding
Further, as required by purchaser, the records according to following (8), and (9) shall be prepared and preserved.

(8) Records of difference in hegitht of foundation of storage tank before assembly

(9) Records of foundation sinking-down amounts before pressure resistance test, at the time of highest weater level in leak test by filling water, and after water draining

Applicable Standards:

JIS B 8243-Construction of Pressure Vessels

JIS G 3101-Rolled Steel for General Structure

JIS G 3106-Rolled Steels for Welded Structure

JIS G 3115-Steel Plates for Pressure Vessels for Intermediate Temperature Service

JIS G 3201-Carbon Steel Forgings for General Use

JIS G 3444-Carbon Steel Tubes for General Structural Purposes

JIS G 3452-Carbon Steel Pipes for Ordinary Piping

JIS G 3454-Carbon Steel Pipes for Pressure Service

JIS G 3457-Arc Welded Carbon Steel Pipes

JIS G 3460-Steel Pipes for Low Temperature Service

JIS G 4051-Carbon Steels for Machine Structural Use

JIS G 4107-Alloy Steel Bolting Materials for High Temperature Service

JIS G 4303-Stainless Steel Bars

JIS G 4304-Hot Rolled Stainless Steel Plates and Sheets

JIS G 4305-Cold Rolled Stainless Steel Plates and Sheets

JIS H 4000-Aluminium and Aluminium Alloy Sheets and Plates, Strip and Coiled Sheets

JIS H 4040-Aluminium and Aluminium Alloy Rods, Bars and Wires

JIS H 4080-Aluminium and Aluminium Alloy Seamless Pipes and Tubes

JIS H 4100-Aluminium and Aluminium Alloy Extruded Shapes

JIS H 4140-Aluminium and Aluminium Alloy Forgings

JIS H 5202-Aluminium Alloy Castings

JIS Z 2343-Methods for Liquid Penetrant Testing and Classification of Indication

JIS Z 3041-Qualification Standards for Welding Procedure of Aluminium and Aluminium Alloys

JIS Z 3105-Methods of Radiographic Test and Classification of Radiographs for Aluminium Welds

JIS Z 3232-Aluminium and Aluminium Alloy Welding Rods and Wires

JIS Z 3604-Recommended practice for Inert Gas Shielded Arc Welding (Aluminium and Aluminium Alloy)

JIS Z 3811-Standard Qualification Procedure for Welding Technique of aluminium and Aluminium Alloy

JIS Z 3861-Standard Qualification procedure for radiographic Testing Technique of Welds

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